The Use of Piezoelectric Technology in Monitoring Heart Rate and Respiratory Rate in Mechanically Ventilated Patients

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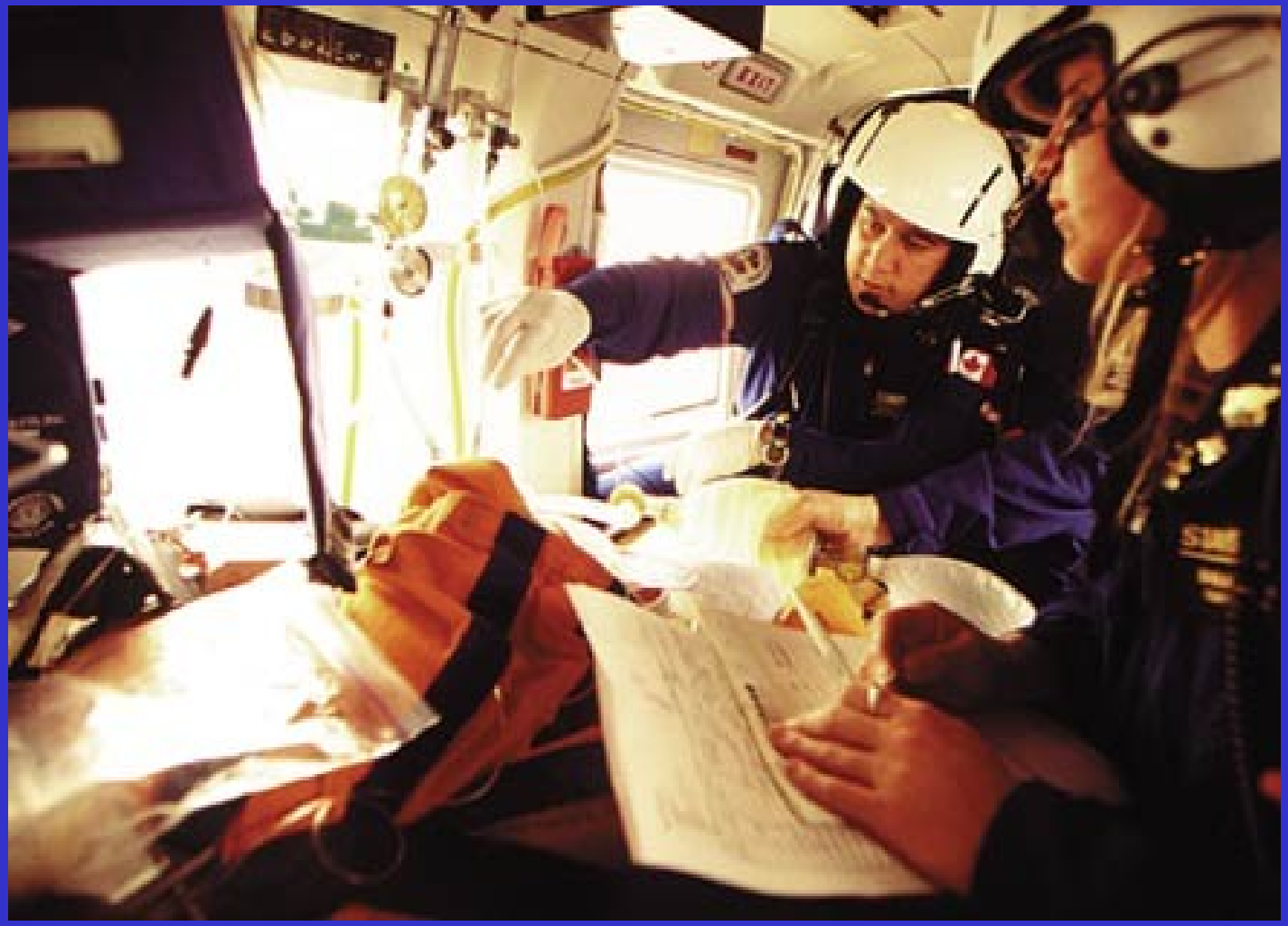

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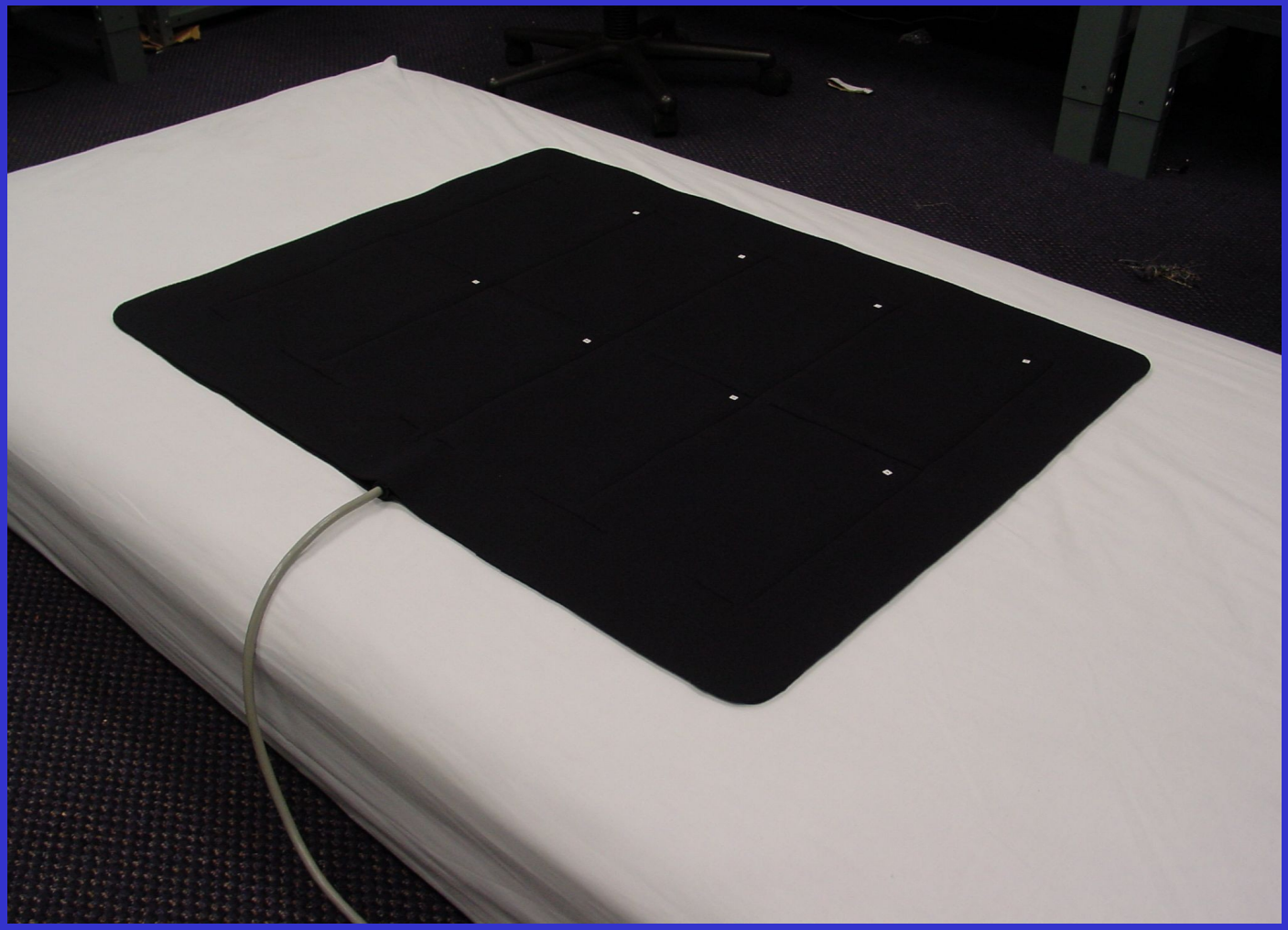
Significance of the Problem

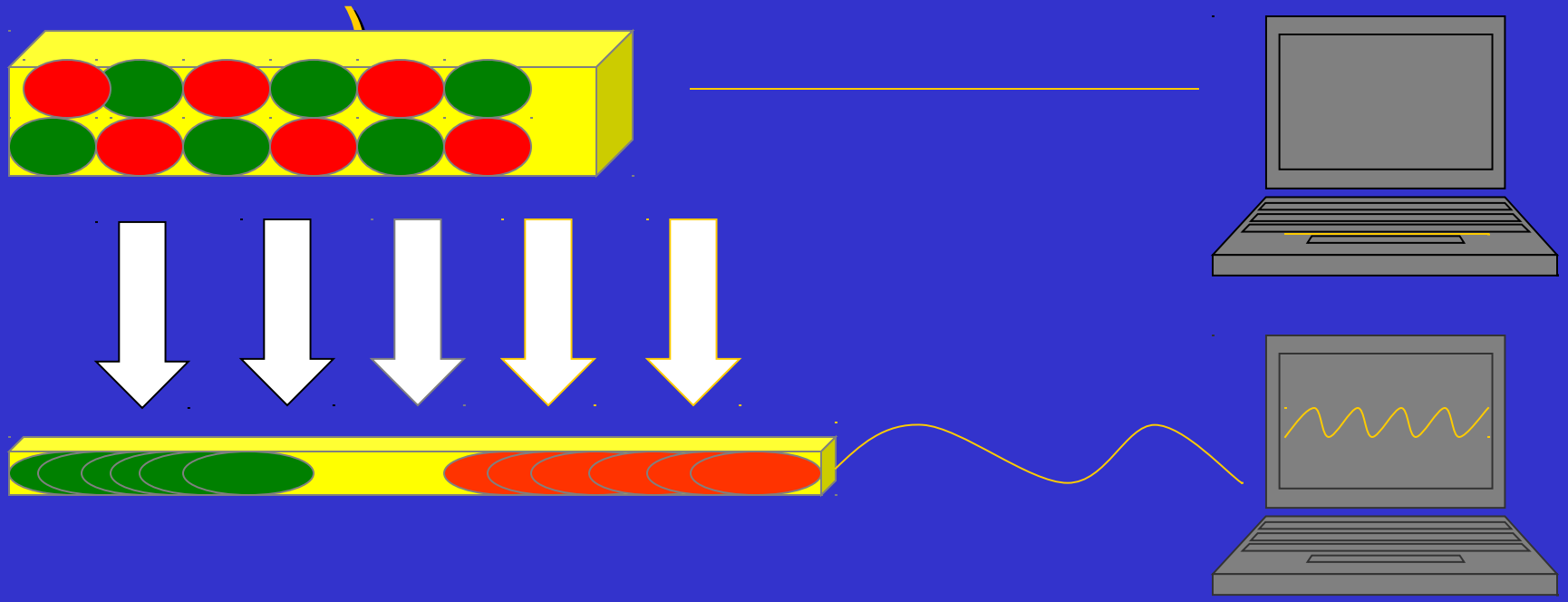
- High noise and vibrations can affect current monitoring devices (austere environments)
  - Automated devices are subject to artifact signals
  - Auscultation can be impossible

- The Passive Physiological Monitor (P2M) has never been tested in a real time clinical scenario
- The P2M has never been tested where the mechanics of breathing have been dramatically altered



Theoretical Framework

Piezoelectric effect (=+,



Purpose and Research Question

- To test the P2M in patients receiving positive-pressure ventilation

- Does the P2M, using piezoelectric technology, correlate with accepted forms of monitoring heart rate and respiratory rate in mechanically ventilated patients undergoing general anesthesia?

Study Design

Correlation Study

- Heart Rate
  - P2M with PCS
  - P2M with ECG
  - EGC with PCS
- Respiratory Rate
  - P2M with PCS
  - P2M with $EtCO_2$
  - $EtCO_2$ with PCS

Population, Sample, and Setting

- Tripler Army Medical Center
- Inclusion criteria
  - Intubated with mechanical ventilation
  - Elective lower extremity orthopedic surgery
  - Supine position
  - Physical Status I or II
  - Age $\geq$ 18 years
  - Body Mass Index $\leq$30 kg/m^2
- Sample size: 30 patients

Procedure for Data Collection

- Obtain informed consent
- Heart rate measured by PCS, ECG and P2M for 1 minute every 5 minutes for a period of 30 minutes
- Respiratory rate measured by PCS, $EtCO_2$ and P2M for 1 minute every 5 minutes for a period of 30 minutes

Data Collection Tool

DATA COLLECTION SHEET

Patient Number:	**ASA Classification:**

Age:	**Height:**
Sex:	**Weight:**

Procedure:

Heart Rate Measurements

Start Time:		**P2M**	**ECG**	**PCS**
+5 min.				
+10 min.				
+15 min.				
+20 min.				
+25 min.				
+30 min.				

Respiratory Rate Measurements

Start Time:		**P2M**	**$ETCO_2$**	**PCS**
+5 min.				
+10 min.				
+15 min.				
+20 min.				
+25 min.				
+30 min.				

Data Analysis

- ANOVA for repeated measures
- Pearson's product moment coefficient

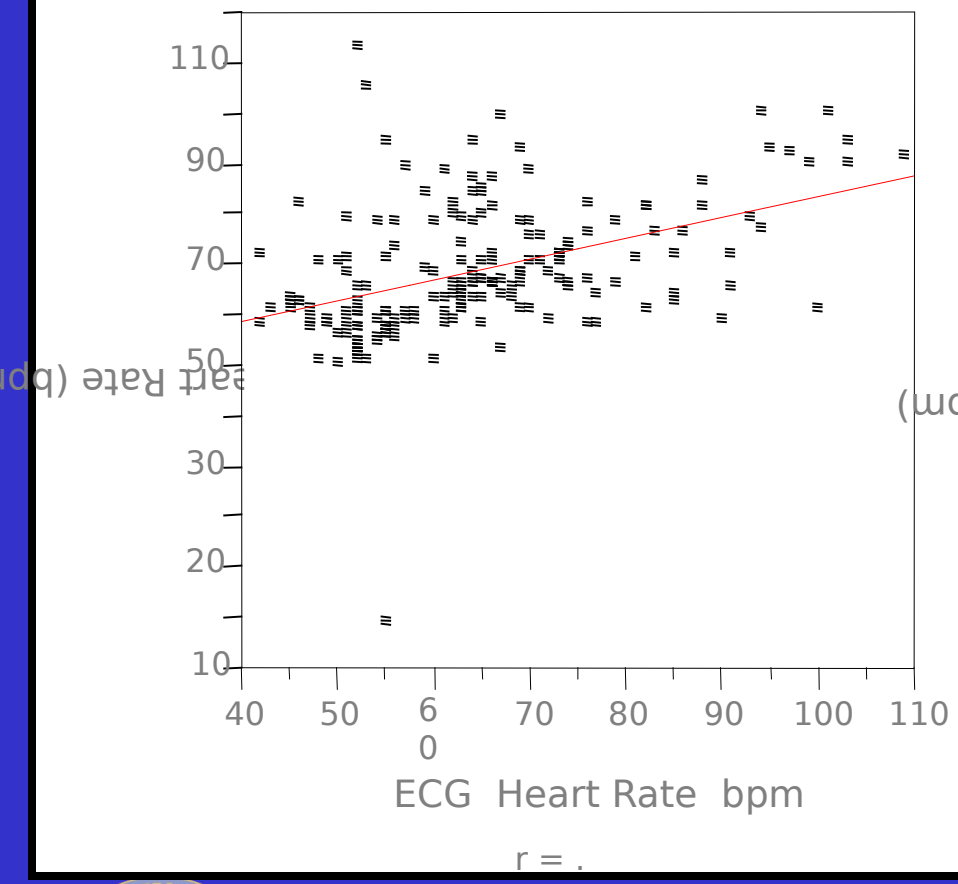
Demographic Data

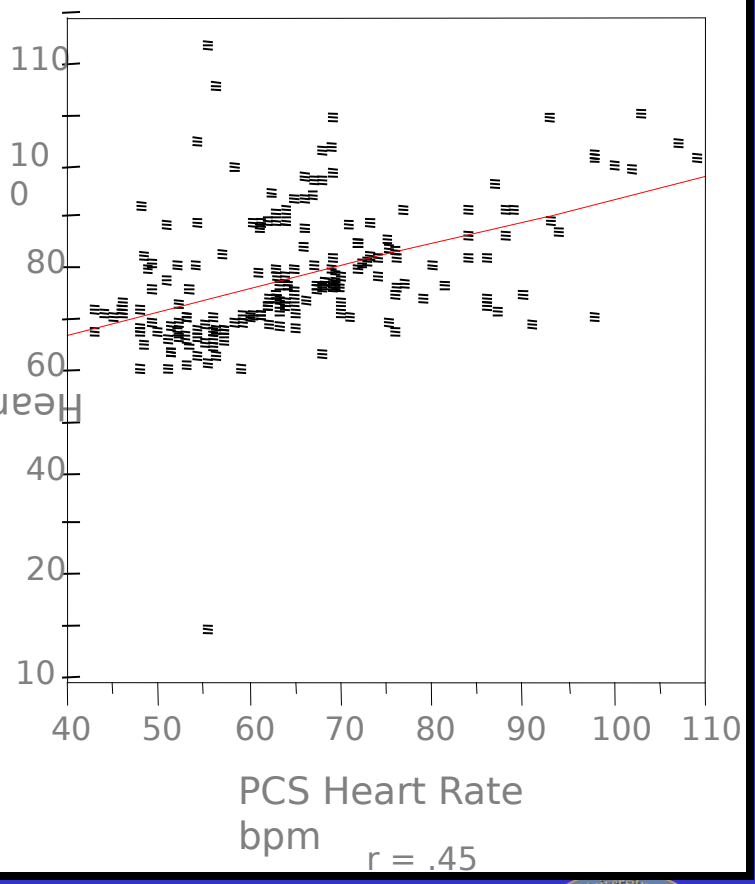
	Mean	Std Dev
Ht (in)	69.15	3.68
Wt.(kg)	79.99	14.21
BMI (kg/m2)	25.43	3.00
Age (yrs)	31.5	10.87
	Males	Females
Sex (frequency)	21	9
	PS 1	PS 2
PS (frequency)	18	12

Analysis of Variance for Repeated Measures

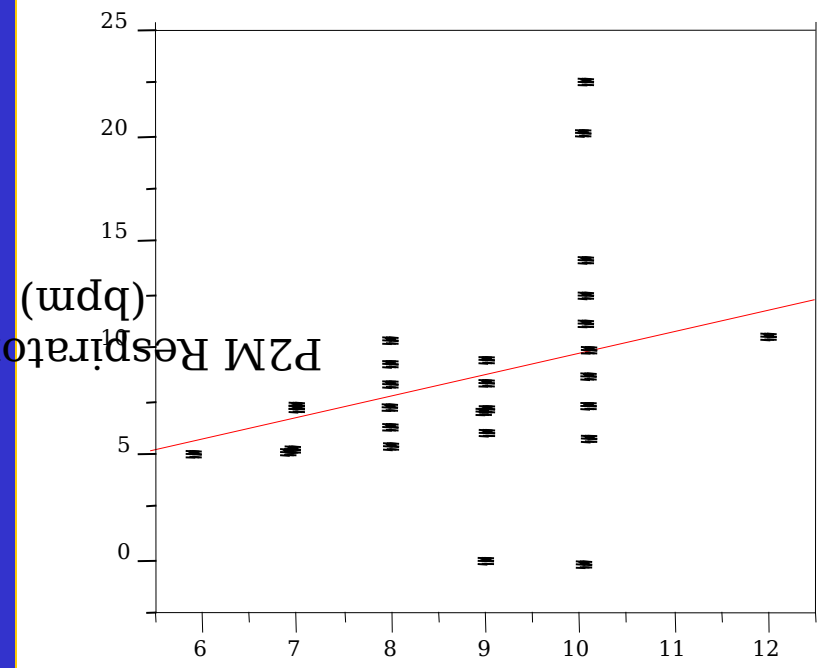
	Mean	Standard Deviation
Heart Rate		
PCS	64.47	13.07
ECG	64.5	13.4
P2M (p = 0.0024)	69.09	13.35
Respiratory Rate		
PCS	8.66	0.07
ECG	8.68	0.07
P2M	8.28	0.16

Heart Rate
P2M to Standard Monitors

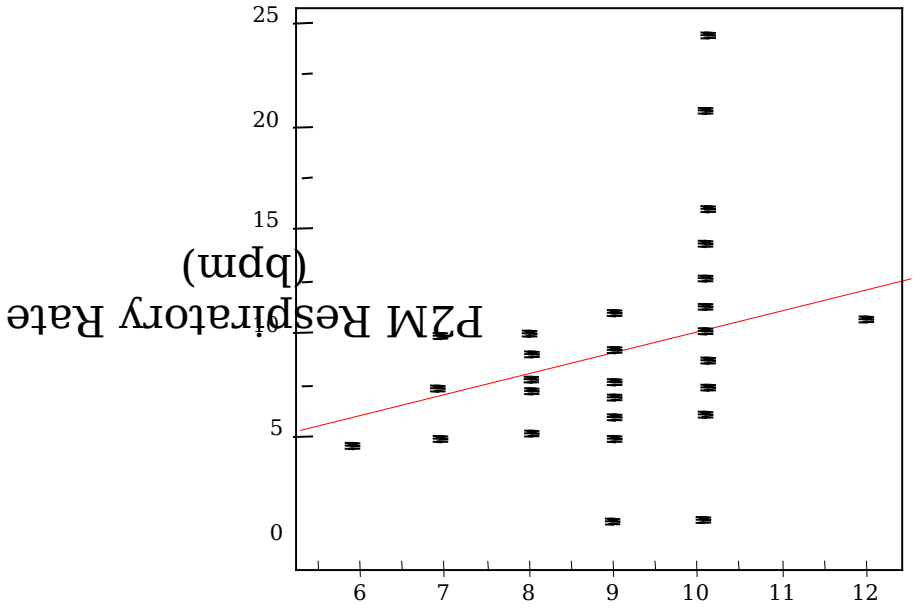




Respiratory Rate
P2M with Standard Monitors



r = .43



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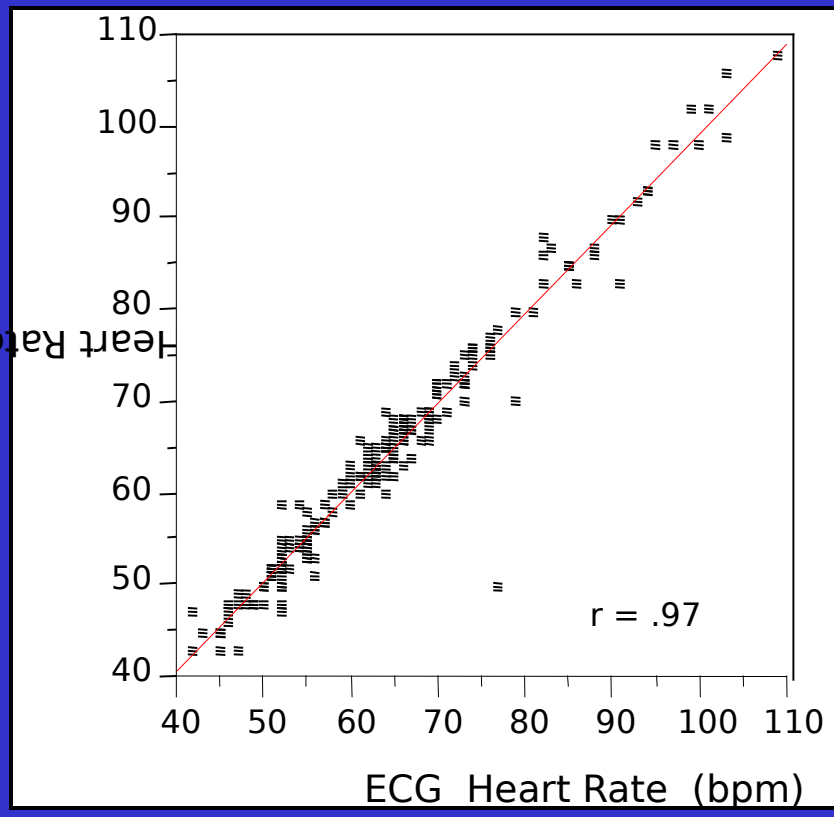
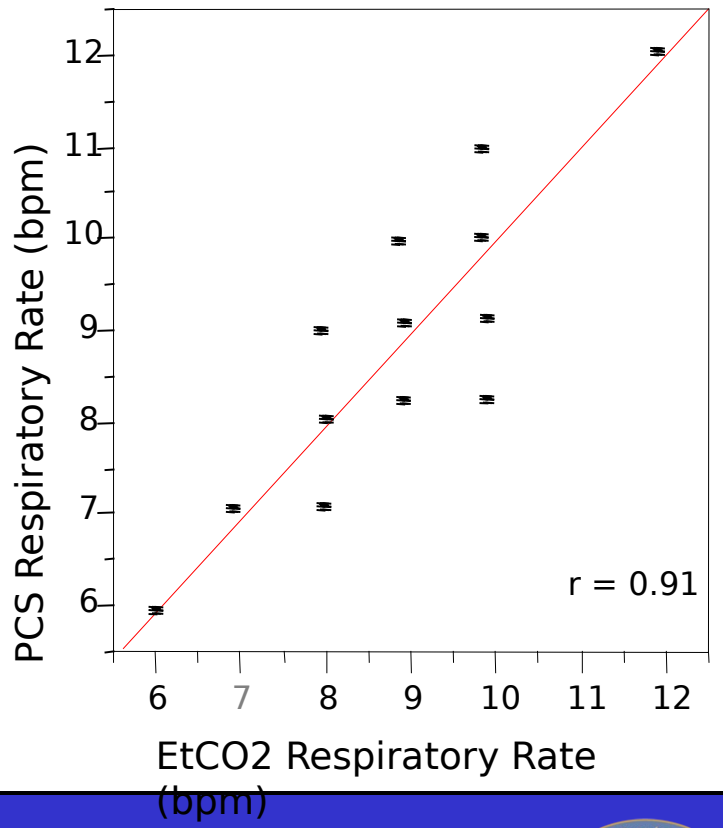
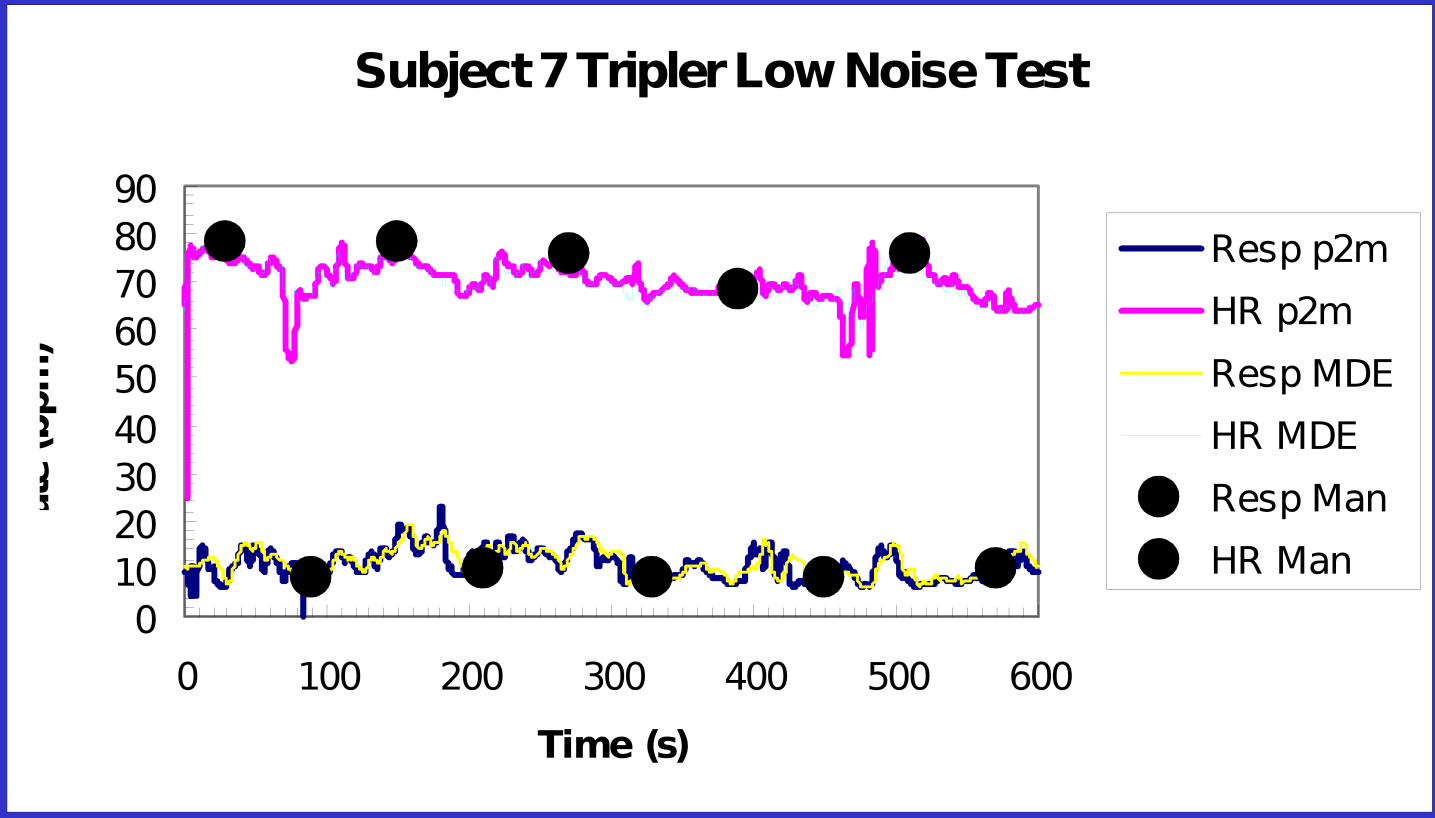
Heart Rate and Respiratory Rate
Standard monitors

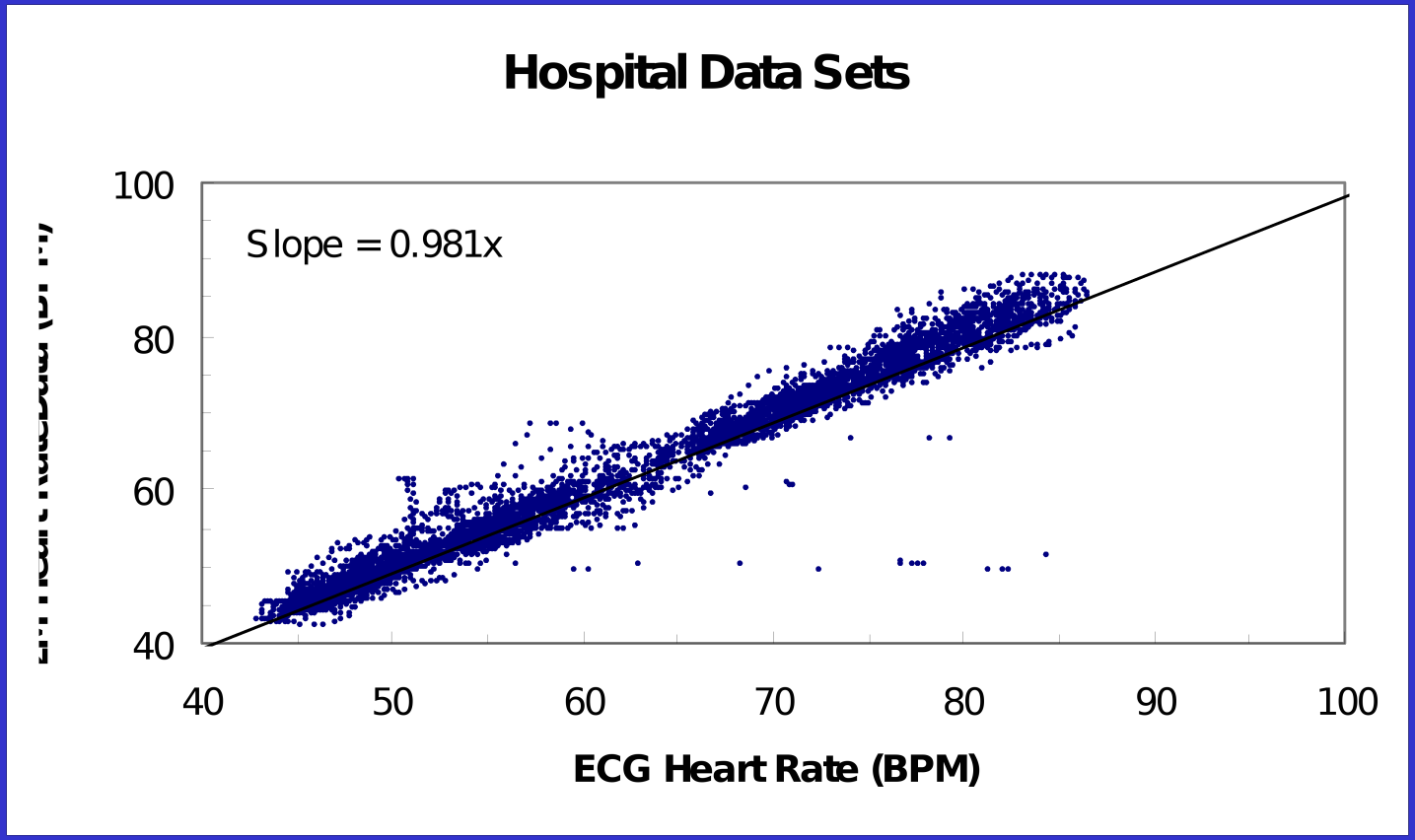


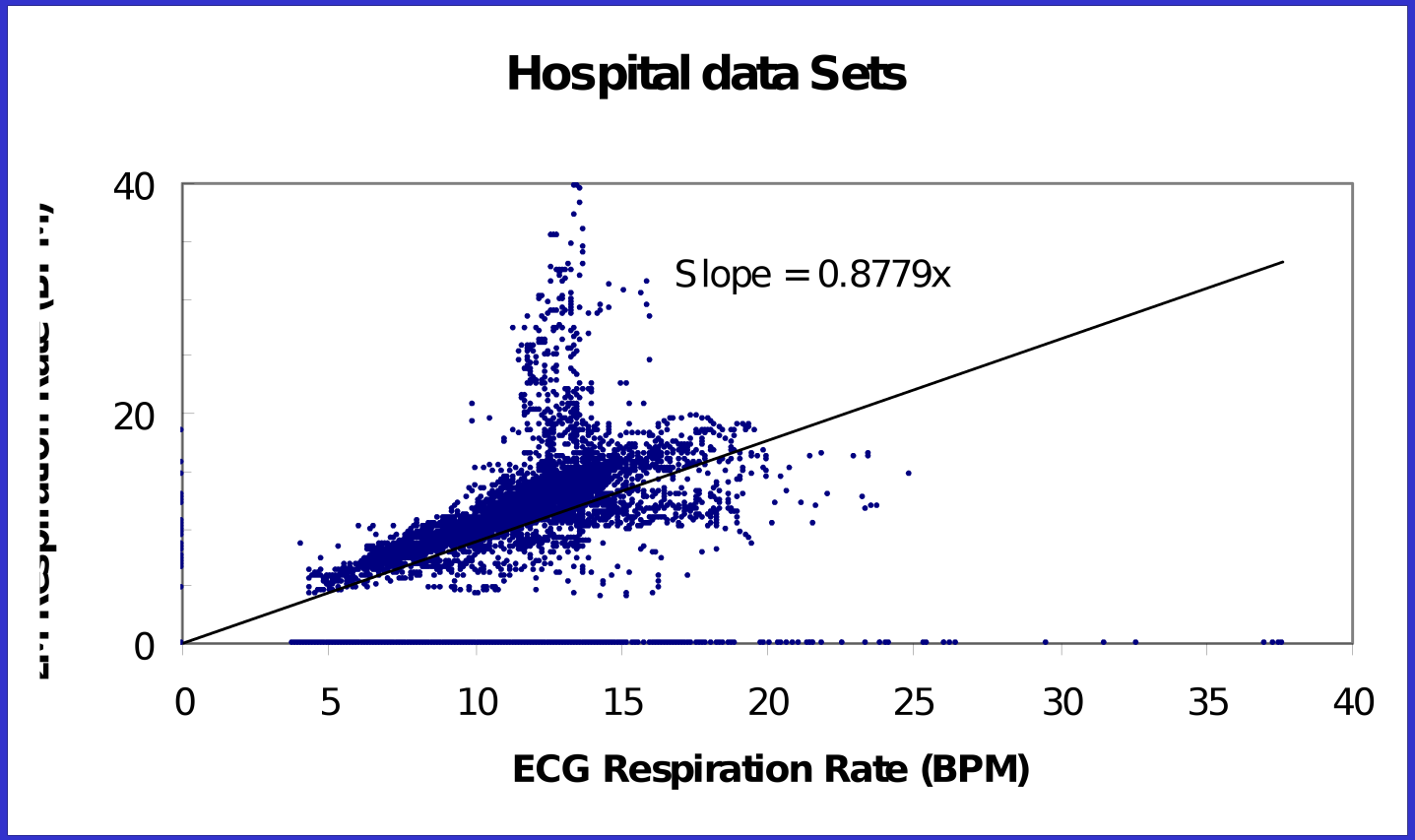


Summary

- RR mean values were similar, no strong correlation
- HR values: P2M tended to overcount
- Algorhythm of software requires further testing


Subject 7 Tripler Low Noise Test
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
Time (s)
Resp p2m
HR p2m
Resp MDE
HR MDE
Resp Man
HR Man


Hospital Data Sets
Slope = 0.981x
100
80
60
40
40
50
60
70
80
90
100
ECG Heart Rate (BPM)


Hospital data Sets
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20
0
Slope = 0.8779x
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5
10
15
20
25
30
35
40
ECG Respiration Rate (BPM)